

Discovery of a plains caldera complex and extinct lava lake in Arabia Terra, Mars: Implications for the discovery of additional highland volcanic source regions

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Several irregularly shaped topographic depressions occur near the dichotomy boundary in northern Arabia Terra, Mars. The geomorphology of these features suggests that they formed by collapse, opposed to meteor impact. At least one depression (~55 by 85 km) displays geologic features indicating a complex, multi-stage collapse history. Features within and around the collapse structure indicate volcanic processes. The complex occurs within Hesperian ridged plains of likely volcanic origin and displays no crater rim or evidence for ejecta. Instead the depression consists of a series of circumferential graben and down-dropped blocks which also display upper surfaces similar to ridged plain lavas. Large blocks within the depression are tilted towards the crater center, and display graben that appear to have originally been linked with circumferential graben outside of the complex related to earlier collapse events. A nearly 700 m high mound exists along a graben within the complex that might be a vent. The deepest depression displays two sets of nearly continuous terraces, which we interpret as high-stands of a drained lava lake. These features appear similar to the "black ledge" described during the Kilauea Iki eruption in 1959. A lacustrine origin for the terraces seems unlikely because of the paucity of channels found in or around the depression that could be linked to aqueous surface processes. In addition, there is no obvious evidence for lacustrine sediments within the basin. Together with the presence of significant faulting that is indicative of collapse we conclude that this crater complex represents a large caldera formed in the Late Noachian to Early Hesperian. Other linear and irregular depressions in the region also might be linked to ancient volcanism. If that hypothesis is correct, it suggests that northern Arabia Terra could contain a large, previously unrecognized highland igneous province. Evacuation of magma via explosive and effusive activity produced localized collapse, might have contributed to nearby ridged plains, and pyroclastic materials erupted from these vents might have supplied sediments in fretted terrain and other deposits. The recognition of volcanoes within Arabia Terra expands the known extent of Noachian-Hesperian volcanism to cover much of the preserved martian highland crust.